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ASTRONOMICAL AND OPTICAL INSTRUMENTS.

Handbuch der Astronomischen Instrumentenkunde. Von Dr. L. Ambronn. Zwei Bände. Mit 1185 in den Text gedruckten Figuren. Pp. vi + 1276. (Berlin: Julius Springer, 1899.)

Die Optischen Instrumente der Firma R. Fuess deren Beschreibung, Justierung, und Anwendung. Von C. Leiss. Mit 233 Holzschnitten im Text und 3 Lichtdrucktafeln. Pp. xiv + 397. (Leipzig: Wilhelm Engelmann, 1899.)

WHOEVER undertakes to write a manual on astronomical instruments, or indeed on the instruments that the study of any branch of physics demands, engages in a task of no common difficulty. It is impossible to turn over the two handsome and ponderous volumes that Dr. Ambronn has compiled, without being struck with the wealth and variety of material that is submitted to our notice. The successive effects of ingenuity as detailed in these volumes are so bewildering in their extent, that it is quite impossible within the limits of a few paragraphs to do justice to the labour and research to which these volumes are an eloquent witness. We can only hope to sketch the scheme, to suggest the lines on which, in the opinion of the author, a text-book on astronomical instruments should proceed. The lucidity of explanation and the wealth of illustration only make the task the more difficult, by demonstrating the number of points that are worthy of comment and attention.

The history of construction, the gradual evolution of the telescope or equatorial, interesting and inviting as such a subject must be, is not allowed to any extent to interfere with the author's project of presenting before astronomers, and before mechanicians, the devices which have been sanctioned by experience and approved after repeated tests. Historical remarks there must be, the comparison of the work and methods of one maker with another, the growth of convenience and power of instruments necessitates descriptions which illustrate historical progress; but such remarks are incidental, and do not concern the main purpose of the work. The present standpoint of mechanical art and the achievements of workshops of known reputation, of themselves cover an enormous ground, which will be studied with profit alike by those who seek to modify existing instruments in a direction which will make them available for special investigations, and by those to whom are necessarily entrusted the duties of manufacture and the details of arrangement.

The work really consists of seven separate treatises, each fairly complete in itself, and the whole forming an encyclopædia, an invaluable work of reference on astronomical instruments. These seven sections are entitled: (1) Accessory apparatus; (2) clocks; (3) separate parts of instruments; (4) micrometers; (5) instruments devoted to special purposes; (6) complete instruments; (7) observatory buildings. The division is somewhat artificial, and cannot be rigorously maintained. For instance, a heliometer might be described as a complete instrument rather than as a special form of micrometer, and there seems no reason why chronographs should not be treated under clocks. Of course, no confusion can possibly arise from such a method of division, because each instrument serves a definite purpose, and its mode of use is perfectly defined. Simplicity of construction is perhaps the best guide to arrangement, and it may be that which the author has followed. Certainly he is well advised in selecting the screw as the first subject for detailed description, and the effective treatment applied to this simple piece of apparatus, whether as a tool in the hands of a mechanic or in the more delicate application to measurement as a micrometer, assures us that we are in presence of a master. We have many useful and ingenious hints both in construction and use, and it is of special importance to notice, as lifting the book out of the category of merely descriptive works, that the author has added an example of the method of determining the errors of a screw as the problem comes before the practical astronomer. But this, and other perfectly legitimate applications of theory to be met elsewhere in the book, suggest a difficulty which, we feel sure, the author has experienced, and introduce a feature which may be considered not altogether satisfactory. How far should a manual of this character concern itself with the theory of instruments? It was evidently the intention of the author not to supply a descriptive work simply, not a manufacturer's catalogue illustrated by many engravings, but to add also a theoretical treatise which might be useful to the astronomical student. But to enter into the theory with that rigorous detail which characterises many text-books, would evidently carry the author too far, and might add another volume to a work whose length is already sufficiently forbidding. There is, therefore, a constant struggle between the theoretical and descriptive parts, in which the former is usually worsted, and the maintenance of the same high standard of excellence common to both is rendered impossible. For instance, the theory of the sextant is in its way more complete than that of the heliometer, simply because the same actual space is approximately allotted to each. One cannot help feeling that the author has not done himself justice in the matter of theoretical discussion, and we hope that he may be tempted to return to the subject and complete his work by giving a theory as precise and thorough as the descriptive portion is clear and satisfactory.

From the screw it would have seemed natural to have gone at once to the reading microscope and the micrometer; but the author has preferred to interpolate the description of levels, collimators, and other mechanical devices, which are not so much astronomical instruments as aids to adjustment and means for inquiry into the stability of the instrument properly so-called. In the second section, Dr. Ambronn breaks away from his account of space measurement in order to describe clocks and time-recording instruments. The treatment here is mainly conducted from a German point of view, and more attention might have been bestowed on improvements that have been suggested by English authorities. But, of course, one admits readily enough that

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he has to do with a German book, written in German for German students and workpeople, and some allowance must be made for patriotism. What would seem a fault in one longitude may be regarded as a merit in another. In fact, a comparison between rival methods of construction and the effort to apprehend the manner in which merits, fully recognised here, are appreciated abroad, constitute one of the main features of interest in this book. For instance, we should gather that the gravity escapement is not so highly considered in Germany as among ourselves.

The separate parts of the instrument which come under detailed description in the next section are axes, the telescope properly so-called with its optical arrangement, and circles. Each of these sections will be found to contain excellent matter, and though one might point out small omissions, to which accident has possibly directed special attention, it would be ungracious to do so without admitting that the author has also collected numerous facts that one has either forgotten or imperfectly apprehended. Under the heading of circles will be found some very interesting remarks on the subject of dividing engines. Whether the introduction here is legitimate we will not stop to inquire, for it might be urged that a dividing engine is no more an astronomical instrument than a lathe or a screwdriver; but the information is so pertinent, and, as we imagine, rather inaccessible, that we cannot but welcome this slight excursion from the observatory to the workshop.

The second volume opens with an account of the micrometer in all its various forms, with wires and without. Under this second head the author places the heliometer, and does not appear prepared to regard this peculiar device as a complete instrument. But his practical acquaintance with its use not only entitles him to speak authoritatively, but supplies him with instances and examples of the method of determining the corrections. We doubt, however, if the popularity of this form of measurement will increase in this country. The fifth section is the only one to which we are inclined to take any exception. In it we have to do with the modern developments of photography, as applied to astronomy, whether in the determination of stellar positions or the interpretation of spectroscopic results. Photometers, spectroscopes, heliostats, and a variety of other apparatus are dovetailed together into this section, with the result that we miss the minute and varied detail that lends a charm to so much of the work. Neither can we altogether accept the author's excuse that a thorough description would lead him too far from his purpose, or that able authorities like Müller and Scheiner have recently discussed in detail the matter treated in this section. To have compiled an account of the instruments used for the determination of position would have been a perfectly intelligible undertaking, and it is in fact what Dr. Ambronn has accomplished with great skill and elaboration. We think he would have been well advised, considering the completeness on which he had planned his work, to have limited his task to such instruments, and refused to consider those that are more particularly adjuncts to the physical laboratory. But it must be clearly understood, that it is only in comparison with the remainder of the book that we notice any falling off from the high level which is elsewhere uniformly maintained. Some 150 quarto pages with 134 illustrations is in itself a treatise of considerable size and merit, and one which we may accept with gratitude.

Under the heading of "complete instruments" we have descriptions of every kind of Transit Circle and Equatorial that ingenuity has suggested and engineering skill has constructed. Indeed, in some instances, such as the particular form of Transit Circle suggested by Dr. Common, the fertility of resource on the part of the inventor has outrun the makers' capacity to realise. Sextants and Altazimuths; the Almucantar and the Chronodeik are not only illustrated by a profusion of diagrams, but examples of results are added. It is impossible to do justice either to the wealth of information or the judicious arrangement which characterise this section on meridional and extra-meridional telescopes. For the numerous forms of equatorial receive the same share of careful attention and historical illustration as do the transit instruments. From Sissons early experiment down to the latest addition to the Cambridge observatory, one might say that no typical construction has been omitted. The more one studies the pages of this excellent encyclopædia of astronomical instruments, the more convinced will he be that it should find a place on the shelves of every observatory, and in the library of every instrument maker.

The second work placed at the head of this article must of necessity partake of something of the nature of a manufacturer's catalogue, but it is so much in advance of the usual compilations of that character, that a very feeble notion of its aim and contents is gained by such a comparison. The production betokens not only a very considerable amount of enterprise on the part of those who are responsible for its preparation, but it intimates the extent of the demand for high-class instruments in Germany, and shows the manner in which that demand is met and encouraged. In reading the book, or portions of it, we experience the same feeling as in being conducted through a scientific exhibition by the ablest of guides. A constant succession of pleasurable surprises meets one at every turn, in noting how difficulties are smoothed away by ingenious appliances. Dr. Leiss, who is well known from his contributions to the *Zeitschrift für Instrumentenkunde*, plays the part of the guide with a skill which suggests that many of the instruments, with whose adjustments he is so familiar, owe their final form to his ingenious skill. There is no necessity to enumerate the various classes of instruments that here find adequate illustration. All that is needed for the physical laboratory on the side of its optical equipment, whether for education or research, finds its place here. Spectrometers and spectroscopes, goniometers and polarising apparatus in wonderful variety, microscopes with endless accessories, are pictured and described. And not only is the student considered, but the lecturer also, for an excellent chapter on projection apparatus is added. The one fact that stands out clearly from this wonderful display is the progress that has been made in recent years, both in the variety of apparatus and the excellence of workmanship.

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